

## CLAIMS

What I claim is:

1. A hybrid energy conversion system comprising
  - A. an internal combustion engine operated with a working fluid of air  
5 containing system fuel in excess of the stoichiometric quantity, with the result that hydrogen, carbon monoxide, hydrocarbons, reduced sulfur or combinations of the same are present in the internal combustion engine product gas exhaust;
  - B. one or more fuel cells that produce electric power through  
10 electrochemical oxidation of product gas containing hydrogen, carbon monoxide, hydrocarbons, reduced sulfur or combinations of the same at the anode surfaces and reduction of air at the cathode surfaces;
  - C. gas transfer means to move at least a portion of the product gas  
15 from said internal combustion engine to the anode surfaces of said fuel cells;
  - D. supply means to bring air to the cathode surfaces of said fuel cells;
  - E. exhaust means to remove spent product gas and air from said fuel cell anode and cathode;
  - 20 F. compressor means to raise the pressure of said air entering the internal combustion engine and the fuel cells from a first lower to a second higher pressure;

- G. afterburner means to mix and combust said spent product gas and air from said fuel cell anode and cathode to form a hot exhaust gas stream at the second higher pressure;
- H. Expander means to reduce said hot exhaust gas stream from the  
5 second higher pressure to a lower pressure and produce shaft power.
2. The hybrid energy conversion system of claim 1 wherein electric or shaft power produced is utilized to operate said compressor means.
3. The hybrid energy conversion system of claim 1 wherein shaft power  
10 produced by the said internal combustion engine and said expander is utilized to generate electric power or perform mechanical work.
4. The hybrid energy conversion system of claim 1 wherein heat transfer devices heat or cool the said internal combustion engine working fluid, internal combustion engine product gas, air supplied to the fuel cell  
15 cathode or spent gasses from fuel cell anode and cathode.
5. The hybrid energy conversion system of claim 4 wherein said heat transfer devices are connected such that thermal energy gained from cooling high temperature streams is used to heat low temperature streams.
6. The hybrid energy conversion system of claim 1 wherein the said gas  
20 transfer means includes processing means to remove chemical species from the product gas stream.

7. The hybrid energy conversion system of claim 1 wherein the said gas transfer means includes processing means to change the product gas chemical composition.
8. The hybrid energy conversion system of claim 1 wherein the said working  
5 fluid is mixed to obtain a substantially homogeneous mixture.
9. The hybrid energy conversion system of claim 1 wherein the said working fluid is heated.
10. The hybrid energy conversion system of claim 1 wherein water, hydrogen,  
10 carbon dioxide, carbon monoxide or hydrocarbons are added to the said working fluid.
11. The energy conversion system of claim 10 wherein the said water, hydrogen, carbon dioxide, carbon monoxide or hydrocarbons are contained in depleted product gas recycled from the fuel cell anode.
12. The hybrid energy conversion system of claim 10 wherein the said water  
15 and carbon dioxide are contained in gas recycled from the afterburner exhaust.
13. A heat engine using air as a working fluid comprising a compressor that operates to raise air from a lower pressure to a higher pressure, a heat source for heating said compressed air, and an expander that expands  
20 said heated compressed air to a lower pressure to produce shaft power, said heat source comprising
  - A. an internal combustion engine operated with a working fluid composed of a first portion of said compressed air containing

- system fuel in excess of the stoichiometric quantity, with the result that hydrogen, carbon monoxide, hydrocarbons, reduced sulfur or combinations of the same are present in the internal combustion engine product gas exhaust;
- 5           B.    one or more fuel cells that produce electric power through electrochemical oxidation of product gas containing hydrogen, carbon monoxide hydrocarbons, reduced sulfur or combinations of the same at the anode surfaces and reduction of air at the cathode surfaces;
- 10          C.    gas transfer means to move at least a portion of the product gas from said internal combustion engine to the anode surfaces of said fuel cells;
- D.    supply means to bring a second portion of said compressed air to the cathode surfaces of said fuel cells;
- 15          E.    exhaust means to remove spent product gas and air from said fuel cell anode and cathode;
- F.    afterburner means to mix and combust said spent product gas and air from said fuel cell anode and cathode to form a heated gas stream at said higher pressure;
- 20          G.    gas transfer means to move said heated gas stream to the inlet of said expander.
14.   The heat engine of claim 13 wherein said internal combustion engine produces or consumes shaft power.

15. The heat engine of claim 13 wherein a portion of the electric or shaft power produced is utilized to drive said compressor.
16. The heat engine of claim 13 wherein a portion of the shaft power produced is utilized to generate electric power or perform mechanical work.